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Diseases of Wheat

The diseases described in this publication may cause yield losses in all wheat crops except overwintering diseases which are specific to winter wheat. Diseases such as stripe rust and powdery mildew can affect all wheats but are generally of major importance only on soft white spring wheats.

Wheat varieties in this fact sheet are described as *RESISTANT* (little or no disease) *INTERMEDIATE* (some disease resistance) or *SUSCEPTIBLE* to a given disease. Different diseases may attack wheat crops from the seedling stage to grain harvest. Most diseases are caused by parasitic fungi and occasionally bacteria and viruses. Some diseases are caused by environmental factors such as nutrient (fertilizer) deficiencies, herbicide problems or weather conditions. All of the varieties that appear in this publication are registered (licensed) in western Canada but not necessarily recommended for use in Alberta.

* denotes varieties that are no longer recommended.

Common root rot and seedling blight

Common root rot is the most important disease of wheat province-wide in Alberta. Average yield losses are approximately 7 per cent annually and may exceed 50 per cent in severely diseased crops. The cause, symptoms, disease cycle and cultural controls are the same for barley.

Cause: Several fungi, primarily *Cochliobolus sativus* and *Fusarium* spp.

Symptoms: Small brown marks (lesions) develop on the roots, lower leaf sheath, or below-ground stems. Lesions may get larger and grow together causing the entire crown area to constrict and turn brown.

Infected plants may be stunted, lack vigor with browning of the crown, stem bases and leaf sheaths. When infection occurs at the seedling stage, young plants may be stunted or killed and the disease is called seedling blight.

Disease cycle: The common root rot fungi attack barley, wheat and other small grains and are found in all cereal-growing areas of the province. Resting structures of the fungi can survive for years in the soil and remain inactive until a cereal host is grown.

Spores germinate in the soil and start primary infections on roots and subcrown internodes. The root and crown area of the infected plants turn brown as the disease progresses.

The fungi produce abundant spores on infected plant parts as the crop reaches maturity. Common root rot fungi are aggressive on plants under stress from drought, high temperatures and nutritional factors.

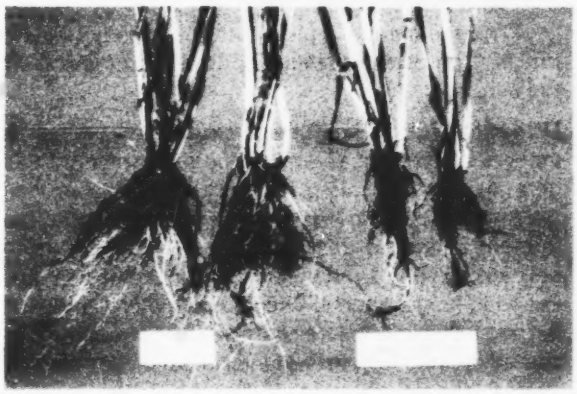

Figure 1. Common root rot on spring wheat — note reduced root growth of diseased plants.

Cultural Control: Shallow seeding (5 cm), when soil moisture conditions are favorable, reduces risk of infection. Crop rotation with noncereals like flax, canola, legumes, and grasses will lower the number of spores in the soil and help reduce common root rot in the following wheat crop.

RESISTANT VARIETIES: *Soft white spring:* Owens.
INTERMEDIATE: *Hard red:* Benito, Columbus, Conway, Glenlea, Katepwa, Kenyon, Lancer, Manitou*, Napayo*, Neepawa, Park, Roblin, Selkirk*, Sinton, Thatcher. *Durum:* Arcola, Coulter, Hercules*, Kyle, Macoun, Medora, Pelissier*, Sceptre, Wakooma, Wascana, Wildcat, PT325. *Prairie spring:* HY320. *Soft White Spring:* Fielder. *Winter:* Sundance, Norstar, Norwin.
SUSCEPTIBLE: *Hard red:* Canuck, Chester, Chinook, Cypress, Leader. *Durum:* None. *Prairie spring:* None.

Chemical control: Seed-treatment fungicides such as carbathiin and maneb reduce seedling blight caused by these fungi, but do not control root rot in older plants. Liquid seed treatments are more effective than dusts.

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Some studies show that potassium chloride used as a fertilizer can reduce the incidence of this disease.

True loose smut

True loose smut occurs wherever wheat is grown. Losses from loose smut in wheat are rarely serious, but they will be persistent if susceptible cultivars are grown and nothing is done to prevent the disease. The symptoms, disease cycle and chemical control are the same for barley.

Cause: A fungus, *Ustilago tritici*

Symptoms: The symptoms become apparent at heading. Diseased heads are blackened and clearly visible among newly emerged green, healthy heads. Most infected heads emerge earlier than normal and except for a delicate membrane, are entirely transformed into a dry, black spore mass.

The membrane ruptures after the heads emerge and the spores are dispersed by the wind, leaving only the bare spike.

Disease cycle: The fungus overwinters within the embryo of the wheat seed. When the infected seed germinates in the spring, the fungus develops inside of the growing point in the plant. As the grain heads are formed, all the tissues except the central spike and delicate covering membrane are invaded and converted to fungal spores. The spores mature at heading out and following rupture of the delicate membrane, are spread by wind to nearby plants. Infection occurs when spores land on open wheat flowers. Following flower infection, the fungus grows into the developing seed and becomes established in the wheat germ or embryo.

RESISTANT VARIETIES: *Hard red:* Benito, Glenlea, Katepwa, Manitou*, Napayo*, Neepawa, Park, Roblin, Saunders, Selkirk*, Thatcher, Lancer, PT325, Wildcat.
INTERMEDIATE: *Hard red:* BW593, Canuck, Chester, Colombus, Conway, Kenyon, Leader. *Durum:* Arcola, Coulter, Hercules*, Macoun, Medora, Pelissier*, Stewart 63, Wakooma, Wascona.
SUSCEPTIBLE: *Hard red:* Chinook, Cypress, Kharkov 22MC, Pitic 62, Sinton. *Durum:* Sceptre. *Prairie spring:* HY320. *Soft white spring:* Fielder, Owens, *Winter:* Norstar, Norwin, Sundance, Winalta.

Chemical control: True loose smut can be controlled by using the systemic fungicide, carbathiin. Carbathiin is found in the following commercial seed treatments; Vitavax Powder, Vitavax Solution, Vitavax Dual Powder, and Vitavax Dual Solution. HY320 must be treated with a systemic fungicide for loose smut and bunt. Liquid treatments are more effective than dusts.

Common bunt (stinking smut, covered smut)

Common bunt, covered smut or stinking smut occurs in all wheat growing areas. Before effective control measures were developed and widely used, bunt ranked as one of the most destructive diseases of wheat in Canada. The symptoms, and disease cycle are very similar to those of covered smut of barley.

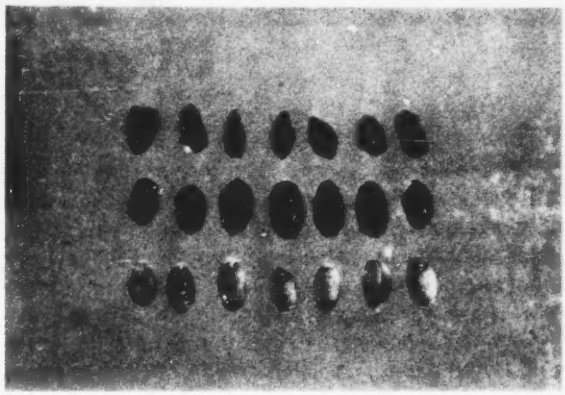


Figure 2. Common bunt — top row bunted grains — middle row healthy grains covered with bunt spores.

Cause: Two closely related fungi, *Tilletia caries* and *T. foetida*.

Symptoms: The symptoms become apparent between heading and maturity. Bunt is identified by the presence of compact, firm black, smutted grains that are enclosed by a persistent covering. The enclosed spores have a fishy odor and are not readily blown or washed away by wind or rain.

Disease cycle: Bunt overwinters on the surface of the grain as seedborne spores. When contaminated seed is planted in the spring, the smut spores germinate and penetrate the growing wheat seedling. The fungus grows within the infected plant until the heads begin to develop. As the wheat heads mature the fungi displace all or most of the grains with smut spores. At harvest time the smutted grains are broken and crushed during threshing. The spores collect on the surface and crevices of the healthy wheat seed completing the disease cycle.

RESISTANT VARIETIES: *Hard red:* Selkirk*, Lancer. *Durum:* Arcola, Coulter, Hercules*, Macoun, Medora, Wakooma, Wascana, Sceptre.
INTERMEDIATE: *Hard red:* Benito, Canuck, Chester, Chinook, Columbus, Cypress, Glenlea, Katepwa, Manitou*, Napayo*, Neepawa, Park, Saunders*, Sinton, PT325, Thatcher. *Winter:* Sundance. *Durum:* Pelissier*, Stewart 63.
SUSCEPTIBLE: *Hard red:* Conway, Pitic 62, Wildcat. *Winter:* Norstar, Norwin, Winalta. *Prairie spring:* HY320. *Soft white spring:* Fielder, Owens.

Chemical Control: Seed treatment fungicides containing either carbathiin or maneb will control this disease. HY320 must be treated with a systemic fungicide for control of both loose smut and bunt. Liquid treatments are more effective than dusts.

Browning root rot

Browning root rot occurs most commonly in wet soils that are low in phosphorus and organic matter. The disease was particularly troublesome in fallow-wheat rotations before 1950.

Cause: A fungus, *Pythium* spp.

Symptoms: This disease occurs in patches. In the early summer, infected wheat plants become pale green and their lower leaves turn yellow, then brown. Small brown lesions on the roots, particularly at the tips of young roots, are sometimes visible. Plants in the infected patch appear unthrifty, but may recover.

Disease cycle: Spores of the *Pythium* fungus may survive in the soil and crop residue for many years. These spores germinate when moisture levels are high and infect the roots of wheat. New spores are formed in the infected plant parts.

Cultural Control: This disease can be controlled by applying phosphate fertilizer at recommended levels and increasing the organic content of the soil by incorporating crop residue.

RESISTANT VARIETIES: None

Chemical control: None.

Take-all (charcoal root rot)

Take-all can cause disease in a wide variety of cereals and grasses including barley, rye, brome and quack grass. The disease is usually most severe when wheat is grown in the same field for two to four years. Yield losses of 30 per cent or more can occur when the disease is severe. Cool moist soils increase levels of disease infection. Nitrogen and phosphorus-deficient soils result in increases in the severity of the disease.

Cause: A fungus, *Gaeumannomyces graminis* var. *tritici*.

Symptoms: Early symptoms include an internal brown discoloration of the lower stems. Infected roots and crowns are dark brown to shiny charcoal black. Severely diseased plants are stunted, produce few tillers, develop white heads and die prematurely. Affected plants that occur singly or in patches throughout the field can be uprooted easily. Lodging of the crop may become a problem.

Disease cycle: The fungus overwinters on fall wheat and grasses or in the residue from infected plants. The disease spreads from plant to plant via the root systems.

Cultural control: Crop rotation is quite effective in controlling the disease. Canola, flax, corn, oats or fallow reduce the occurrence of take-all. Alfalfa, bean or soybean crops preceding wheat may not be helpful and nitrate nitrogen fertilizers may promote the disease. Maintaining adequate levels of phosphorus and potassium in the soil encourages root growth and lessens disease severity. Liming of acid soils will increase the incidence of take-all.

RESISTANT VARIETIES: None.

Chemical control: None.

Figure 3. Take-all on spring wheat — note charcoal black lower stems.

Tan spot

Tan spot is common on wheat throughout the province. It also occurs on brome and wheat grasses. The spots reduce the photosynthetic area of the leaves and may cause losses in grain yield, especially when the upper leaves are affected. Occasionally, the fungus attacks the heads and contaminates or infects the grains.

Cause: A fungus, *Pyrenophora tritici-repentis*.

Symptoms: The symptoms first appear as small tan-brown flecks on the lowest leaves, these small areas then expand to blotches that have pointed ends. Joining of blotches usually occurs under wet conditions favorable for disease development. Heavily infected leaves may wither and die. If the seed is infested, a pinkish coloration can develop and the seeds may be smaller and wrinkled.

Disease cycle: The fungus overwinters on host crop residue. Spores are produced in the spring and are carried by the wind to growing plants. At least six hours of wetness is required for infection. Seedlings may become infected, but the disease is not very obvious until heading. Spread during the growing season is by spores produced on diseased leaves during periods of wet weather.

Cultural Control: A rotation that includes non-host crops, such as other cereals, canola, flax, corn, soybeans, potatoes, or alfalfa is helpful. Burying wheat residue prior to seeding will reduce the amount of airborne spores in the spring.

RESISTANT VARIETIES: None.

Chemical control: Dithane M-45 (See label for directions).
Temporary registration only.

Septoria leaf blotch

The Septoria complex of diseases occurs on wheat, barley and other small grains in the province. Infections producing yellowing and browning of the leaves and heads result in shrivelled grain.

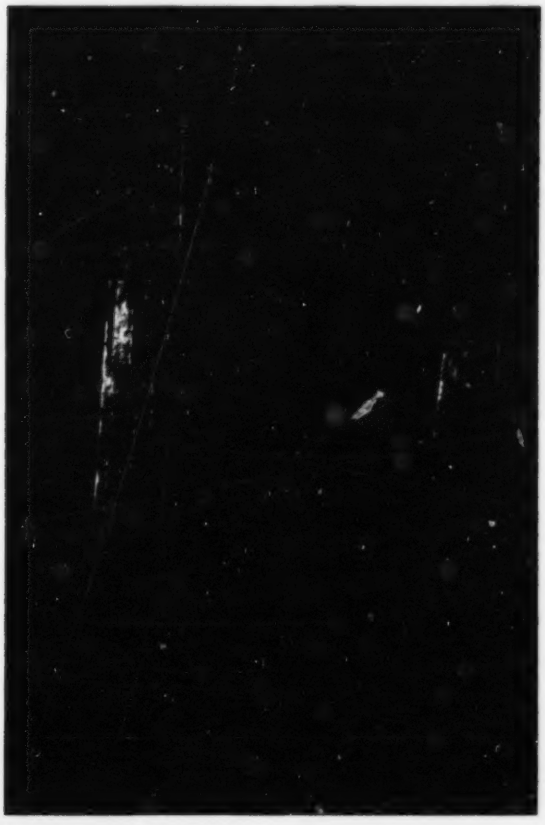


Figure 4. Septoria leaf blotch on spring wheat.

Cause: Two similar fungi, *Septoria tritici* and *S. nodorum.*

Symptoms: Symptoms develop throughout the growing season. Yellow flecks first appear on the lower leaves, especially those touching the ground. Later, yellow to brown spots may develop on all of the plants. On the leaves, yellow bordered marks are at first restricted by the veins and develop along the leaf. The spots eventually join up. Leaves affected at their bases may be killed. Glume infections on the grains also occur, beginning at the tips and developing downward as brown marks that later produce pepper-like black dots. Grains can be severely shrivelled.

Disease cycle: The fungi overwinters on seed or crop residue as well as the leaves of winter wheat. Spores initiate the disease on wheat in the fall (winter wheat) or the spring . Spores are produced in abundance on diseased leaves and glumes when the weather is wet. Spores are spread within the crop by splashing rain infecting new growth. Wet windy weather favors disease outbreaks, while dry weather arrests disease development. In winter wheat, disease intensity normally is low in the autumn. In spring, the disease develops slowly until heading and rapidly afterwards if wet weather conditions occur.

Cultural control: A rotation alternating wheat with non-cereal crops helps reduce the amount of disease. Burying crop residue will lower spore levels.

RESISTANT VARIETIES: None
INTERMEDIATE: *Hard red:* PT325
SUSCEPTIBLE: all other varieties

Chemical control: Dithane M-45 (See label for directions)
Temporary registration only.

Fusarium head blight (Scab)

Fusarium head blight is common in humid regions and is seen as a premature ageing of grain head spikelets. Barley, oats and rye are also susceptible, and yield losses from floret sterility and poor seed filling may be important in all cereal crops. The most important economic significance of this disease is the possibility that the grain may become contaminated by poisons such as vomitoxin, which may be produced in the kernels by the fungus. Such seed may be toxic or unpalatable, especially to nonruminant animals. Wheat is only acceptable for human consumption when it is virtually free of such toxins. Thus, when the reduction in quality and marketability resulting from the presence of these toxins is considered, the economic importance of this disease is magnified far beyond its yield loss. The disease is relatively uncommon in western Canada but it can cause considerable quality losses in the central and eastern provinces.

Cause: A complex of fungi, *Gibberella zeae, Fusarium avenaceum, F. culmorum* and *F. poae.*

Symptoms: The symptoms are most conspicuous on wheat and barley. Head blight is recognised by premature bleaching of one or all of the spikelets in the head; infected spikelets are often sterile. Infection of the spikelet stalk may result in the seed above the point of infection not filling. Seeds from blighted heads are often small and shrivelled. Small dark spots and a fungus growth with an orange to pinkish tinge can often be seen on diseased heads. Infected grain is lighter in weight and individual kernels may be white or pinkish.

Blight symptoms often appear after flowering, usually following a period of continuous moisture and warm temperatures.

Disease cycle: Head blight fungi overwinter as mycelium or spores in soil, grass and crop residue. Seedlings are often infected at emergence. In wheat seedlings, infection is usually restricted to older stems around the crown region; however, older leaves may also be infected. As warmer moist weather develops, spores spread by rain splash and wind come into contact with the upper parts of the plant. Infection of the head may take place from pre-emergence to the soft dough stages.

Cultural control: The integration of a number of control measures will reduce the levels of head blight fungi. Fungicide seed treatments to ensure good emergence, field sanitation to destroy crop residue and crop rotation sequences involving noncereal or grass crops, are advised. Wheat planted after corn seems to be particularly prone to this problem possibly because of the large quantities of this fungus that can be produced from corn residue.

RESISTANT VARIETIES: None

Chemical control: None

Ergot

Figure 5. Ergots from spring wheat

Ergot occurs on a wide range of cereal crops and grasses. Although it is usually most prevalent on rye and triticale, it attacks, in decreasing order of susceptibility durum wheat, common wheat, barley and sometimes oats. Because of its many hosts, both cultivated and wild, and because the ergot bodies or sclerotia are toxic to man and animals, this is a serious disease even though its effects on yield are minimal. As few as four ergot bodies in 500 g of seed will result in the downgrading of top-grade wheat. Ergot contamination in excess of 0.25 per cent in wheat can result in downgrading to "sample", with heavy economic losses to the grower. Ergot sclerotia cause serious problems for livestock when consumed in feed. Wheat that contains more than 0.1 per cent ergot bodies is considered dangerous to livestock. Ergot-contaminated grain should never be fed to pregnant or lactating cows.

Cause: A fungus, *Claviceps purpurea*.

Symptoms: The most characteristic symptoms of ergot are the dark purplish or black ergots that replace kernels in affected heads. Affected spikes may contain one to many ergots.

Earlier in the season, before these black bodies are visible, ergot infection can often be detected by close observation of the heads. Soon after flowering, droplets of a sticky liquid appear on the surface of infected florets; this liquid called honeydew contains spores which are spread by rain and insects to other grain florets. Ergots when broken have a purplish interior color. Sclerotinia sclerotes which may contaminate grain from infected volunteer canola or mustard resemble ergots but have white interiors.

Disease cycle: Ergots overwinter in the soil. In the spring, the ergot germinates and produces a fruiting body or mushroom. These tiny mushrooms produce spores which infect the open grain florets and the fungus infects the immature seed. Further spread in the crop results from the rain and insect-borne spores from this honeydew stage described previously.

Cultural control: Sanitation and management are the best control measures available to growers. Mowing the grass headlands before they flower prevents the build-up of ergot by reducing or eliminating ergots for the following year. Wheat should not be grown following rye in rotation. Allow at least one year between successive crops of rye, triticale, wheat and barley. If a cereal crop is seeded on stubble where ergot is known to have occurred, it is advisable to cultivate deeply to bury the ergot bodies to a depth of at least 5 cm. Always use clean seed, that which is free of ergot bodies. When harvesting heavily infected crops, it may be helpful to keep the more heavily infected grain from the perimeter of the field separate from the rest of the crop. This is because most infection originates from the headland grasses and heavy infection is usually confined to the edges of the crop.

RESISTANT VARIETIES: None

Chemical control: None.

Stem rust

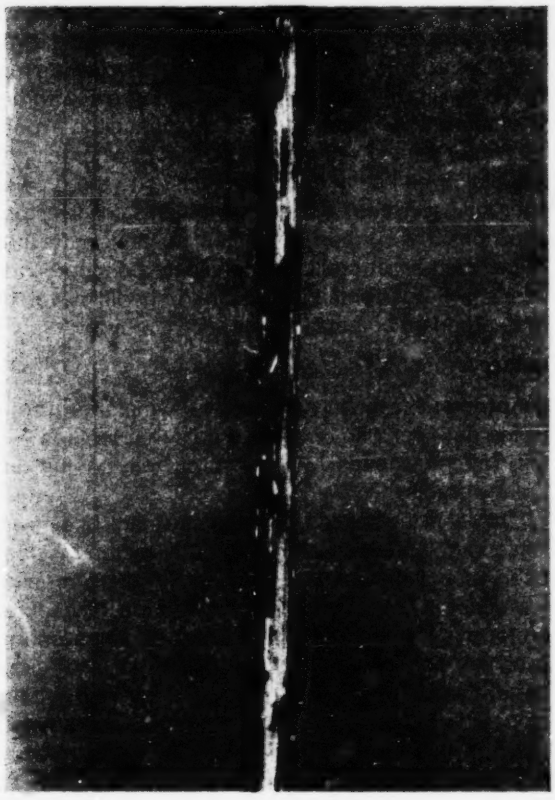


Figure 6. Stem rust on hard red spring wheat — Rust pustules occur as "slits" along the stem.

Stem rust is an important disease of wheat in Manitoba and southeastern Saskatchewan but never has been much of a problem in Alberta. Since many of our publications cater to a prairie-wide audience, this disease has been included primarily for information purposes. Infectious rust spores arrive in Manitoba early in the growing season. They blow in from the United States, up the Mississippi valley and into the Red River valley. By the time rust spores drift into Alberta, it is generally too late in the season to damage the cereal crop. In this province, the disease affects only the immature second growth tillers or tillers of late maturing varieties. Stem rust affects cereals by severely damaging stem and foliar functions causing reduction in yield and grain quality.

When a stem rust infected crop is swathed or combined, masses of spores are released. Rust spores, like a fine dust, interfere with breathing as well as the air intakes on machinery. The rust spores can also cause respiratory problems if the straw is used for feed or in bedding down livestock.

Stem rusts attack barley, rye and oats as well as grasses. Each host crop has a strain of stem rust that is very specific to that crop. This means that wheat stem rust does not attack rye or vice versa. In addition to having strains specific to each crop, stem rust can also be separated into distinct (physiologic) races, differentiated by their ability to attack only certain wheat varieties and not others. These races are not stable but are constantly changing. Continued research must be done on rust resistance to keep up with the newly developing races of this fungus that blow in from the U.S. Several hundred different (physiologic) races of the stem rust fungus have already been recorded. Only recommended varieties of hard red spring wheat are resistant to these new rust fungus races.

Stem rust of wheat is commonly called brown stem rust or black stem rust depending on the type of spore being produced by the fungus in the course of the growing season.

Cause: *Puccinia graminis* f. sp. *tritici*

Symptoms: During the spring and early summer, long, narrow, elliptical, reddish-brown pustules appear, primarily on the stem but also on the leaf and leaf sheath. At later stages, pustules may also appear on the neck and glumes of the wheat spike. These pustules contain masses of reddish-brown spores (urediospores), hence the name brown rust. These spores are then carried by the wind to infect other wheat plants. Later in the season as wheat plants ripen, rust pustules darken as the fungus produces black spores (teliospores) hence the name black stem rust. These teliospores are very thick walled and are the overwintering structure of the fungus. Infected plants usually produce fewer tillers, set fewer seeds per head and have small, shrivelled seeds with poor milling quality and food value.

Disease cycle: Stem rust is hetereocious, which means it requires two different host species to complete its disease cycle. These species are wheat and barberry (*Berberis vulgare*), a small deciduous shrub that occurs mostly in cultivated forms.

When rust spores (urediospores) blow in from the United States, they infect the wheat plant and pustules form in a week to 10 days. These pustules then break open releasing masses of brown spores infecting the surrounding wheat plants. Later in the year as fall arrives, the fungus starts to produce black overwintering teliospores. These lie dormant with the crop residue over the winter. In spring, they germinate and produce small spores called basidiospores. These can only infect young leaves of the barberry shrub. On the barberry, the fungus then produces two more types of spores - pycniospores and later on aeciospores — this represents the sexual reproductive stage of the fungus. The aeciospores infect wheat resulting in rust pustules that produce brown spores (urediospores).

Since wild barberry does not occur in Alberta, there is no alternate host to produce infectious spores even if the black rust spores manage to overwinter. Because of

this, infectious spores must be blown in from the southern United States where the barberry grows. Usually these spores arrive too late in the growing season to do any damage so that rust susceptible varieties of wheat can be grown in Alberta.

Control: The most effective and practical way on the prairies to control stem rust is by growing resistant varieties suitable for your growing area. Early maturing varieties, early sowing and avoiding intensive cereal cropping, particularly in moist, wind-sheltered areas will also reduce the incidence of stem rust.

RESISTANT VARIETIES: *Hard red:* BW593, Benito, Columbus, Conway, Glenlea, Katepwa, Napayo*, Neepawa, Roblin, Selkirk*, Sinton. *Durum:* Arcola, Coulter, Hercules*, Macoun, Medora, Wakooma, Wascana, Wildcat, PT325. *Prairie spring:* HY320
INTERMEDIATE: *Winter wheat:* Norwin
SUSCEPTIBLE: All others.

Eradication of the barberry plant in parts of Canada and the U.S., especially those close to cropping areas, helps to reduce the current seasonal aeciospore infection, as well as eliminates the sexual reproductive phase which could result in the recombinations of genes to form new races that can attack rust resistant wheats. The barberry, which is the alternate host, is not native to North America and was introduced from Europe. Several successful eradication programs have been established in Canada and the United States but the programs must be continual to prevent reinfestation of the land by the wild barberry shrub. *Federal quarantine laws* make it illegal to grow or import into Canada varieties of the barberry shrub family.

Chemical control: Several fungicides are available which can effectively control stem rust. In most cases, they require four to ten applications and this would neither be practical or economical for most farmers.

Winter Injury

The most important disease of winter wheat in Alberta is winter injury. Winter injury or winterkill are terms used to describe damage to overwintering wheat from diseases or environmental stress. All cold hardy winter wheat varieties are susceptible to several snow mold fungi. These fungi cause severe damage under the right conditions. When there is little or no snow cover, winter wheat can be damaged by environmental stresses, such as subfreezing temperatures, standing water, ice-encasement, heaving and desiccation. In southern Alberta, warm chinook winds may rapidly melt the protective snow cover, causing dehardening of the plants, exposing them to drying winds and frosts. Usually snowmolds are most damaging when an early snow cover on unfrozen soil persists throughout the winter and into early spring, maintaining high humidity and temperatures of about 0°C. Cottony snow mold fungi are found throughout Alberta, while sclerotinia snow mold is common in the central and northern areas. This fungus can cause damage under snow-covered frozen soil.

Cause: Cottony snow mold *Coprinus psychromorbidus* (LTB and SLTB phases) sclerotinia snow mold *Myriosclerotinia borealis*, and environmental stresses.

Symptoms: Because of the complexity of the causal factors involved, the diagnosis of winter damage is difficult when growth resumes in spring. Damage is often assessed on the basis of symptoms and a knowledge of the terrain, soil conditions, management practices and weather conditions since seeding. Injury from standing water and ice encasement can be expected in heavy, or compacted poorly drained soils, when freeze-thaw cycles and rain have occurred during the winter. Desiccation injury often occurs on exposed hills and on bare, windswept fields. Damage from snow molds is most prevalent and damaging following a long, snowy winter, especially where snow has accumulated in drifts. Snow mold damage may occur in patches or in large areas or it may cause thinning of the stand within the rows.

The LTB (low temperature basidiomycete) phase of the cottony snow mold fungus produces only white mycelium on infected plants at snow melt. The SLTB (sclerotial low-temperature basidiomycete) phase of cottony snow mold produces less abundant, cobwebby aerial mycelium and small gray to black sclerotia on affected plants. The SLTB is less damaging than the LTB phase. Sclerotinia snow mold produces black, flake-like sclerotia on affected plants.

Disease cycle: The snow mold fungi differ in geographic distribution, and each causes damage under specific environmental conditions. They survive over summer as sclerotia or mycelium in soil or residue; some, such as *M. borealis* occur naturally and may be endemic in grasses.

Cultural control: Management practices have a marked effect on winter survival. Attention should be paid to the effect of preceding crops and land preparation on the incidence of disease. Cultivars of hard red winter wheat that have been developed for southern Alberta are more tolerant of cold and ice-encasement than those grown elsewhere in North America. In colder, low snowfall areas of the prairies, growers have had some success in growing the hardier red winter wheats by seeding them into the stubble of the preceding crop, which helps to trap a light, protective snow cover. However, the seeding of wheat into wheat stubble is not recommended.

Resistance to snow molds and environmental stresses is greatest in plants sown early, which have accumulated good food reserves and are cold hardened before winter. Heavy applications of nitrogen to the crop in the fall should be avoided.

RESISTANT VARIETIES: None.

Chemical control: Fungicides applied to turf grasses in late fall provide effective control of snow mold diseases, but none is registered for use on cereals.

Cephalosporium stripe

Cephalosporium stripe occurs on winter wheat under cool, moist conditions and is most severe in fields where wheat is grown continously. Winter rye and several grasses are also susceptible. The fungus exists in the soil but it can grow into wheat plants where it blocks the transport of water and nutrients, resulting in reduced seed size and number.

Cause: A fungus, *Cephalosporium gramineum.*

Symptoms: Pale green, longitudinal stripes through the leaf blade, sheath and stem are characteristic of this disease. Veins within the pale stripe are usually dark. The stripes become brown and at maturity darkened areas may be found on the stems, especially at the nodes. Plants may be stunted, ripen prematurely and develop white heads.

Disease cycle: This soil-borne fungus can persist indefinitely in the soil and sporulates abundantly in cool, wet soils. Root infections occur from spores formed on residue in or on the soil. The fungus enters the plant's water-conducting system through wounds in the roots. It is then transported upwards to the nodes and leaves. Tiny, gray-black, superficial spore-producing structures are formed; when moist these structures appear yellowish-brown and produce spores in slimy masses.

Cultural control: Crop rotation with legumes, corn and spring cereals offers the most practical means of control. Management of grassy weeds, removal of infested straw and burial of residue by plowing to a depth of at least 8 cm will reduce disease carryover.

RESISTANT VARIETIES: None.

Chemical control: None

Eyespot

Eyespot is a disease that affects the lower stem and sheath of wheat plants, causing stem breakage, white heads and death of tillers, reducing grain yield.

Cause: A fungus, *Pseudocercosporella herpotrichioides.*

Symptoms: Infection of winter wheat seedlings can take place in the fall or spring but the characteristic eyeshaped lesions usually appear on the leaf sheath near soil level in spring. The lesions of eyespot are at first light tan with brown margins, becoming dark in the centre and extending through the sheath to the stem. In older infections, the lesions may be seen on the stem when the overlying sheath is stripped away. Fungus mycelium may be present in the hollow part of the stem, and on the outside forming a dark growth on the surface, giving older stems a charred appearance. Severely affected tillers develop white heads and may weaken and lodge.

Disease cycle: The eyespot fungus overwinters as fungus mycelium in crop residue and is most destructive under cool, moist conditions. Spores develop quickly and abundantly in the fall and spring and are spread by splashing rain. Infection occurs rapidly at temperatures of 6-15°C but is inhibited at warmer temperatures. It is most severe where wheat is grown repeatedly.

Cultural Control: The eyespot fungus does not survive in the soil in the absence of crop residue. Therefore rotation with noncereal crops offers an effective means of control; spore production falls rapidly as infected straw breaks down in the soil. Management practices that accelerate straw rotting would shorten the rotation period.

RESISTANT VARIETIES: None.

Chemical control: None

Wheat streak mosaic virus

This virus disease occurs wherever winter wheat is grown. Damage can range from a few infected plants to complete crop failure.

Cause: A virus, transmitted from plant to plant by a microscopic plant feeding mite.

Symptoms: This disease may not be visible in the fall but in early spring new leaves are light green with yellow flecks. Light infections of this disease usually occur along the edges of fields. Infected plants remain stunted or die-off. Another similar disease called wheat spot mosaic may also be present.

Disease cycle: In the fall, winter wheat can become infested with virus-carrying mites that overwinter on the wheat seedlings. In early spring, the mites multiply rapidly and although wingless they are tiny enough to be wind-borne from plant to plant. From the winter wheat, the mites can carry the virus to spring sown cereals. If winter wheat is sown adjacent to immature standing crops of spring cereals, the mites will move onto the emerging winter wheat, thus maintaining the disease cycle.

Cultural control: Control of this disease depends on breaking the life cycle of the mite. a) Spring cereals should not be planted next to winter wheat if the disease is present. b) Winter wheat should not be planted near immature spring cereal crops. c) Delay planting of winter wheat into September. d) Plough under or destroy volunteer cereal seedlings at least a week before seeding winter wheat. The mites cannot survive longer than 10 days without the living cereal plants on which they

feed. These procedures break the life cycle of the mites and therefore prevent the spread of virus.

RESISTANT VARIETIES: None

Chemical control: None

Yellow dwarf

Barley yellow dwarf is an aphid-transmitted virus that affects cereals and grasses. The aphid carriers, (there are five aphid species), do not overwinter in Alberta. The virus is introduced into the wheat crop each year by aphids that migrate from the United States. The aphids bring the virus with them or they pick up the virus when they feed on virus infected perennial grasses. The disease usually develops too late in the season to cause significant yield loss. Winter wheat might be severely affected if high numbers of virus infected aphids buildup on spring cereals by the fall and subsequently move onto fall sown winter wheat.

Cause: A virus spread by aphids.

Symptoms: Symptoms in wheat are yellowing and bronzing of leaves and stunting of the whole plant. Heads and grains are reduced in number and size. Depending on growth stage at infection and strain of virus, infested plants can remain symptomless.

Disease cycle: Aphids that pick up the virus can infect healthy plants for life (40 days). The wingless and winged aphids spread the virus infection within the crop so that in some years 100 per cent of the plants may be infected. Favorable winds moving up from the south and cool moist summers favor aphid population build-up and extensive spread of virus disease, as in 1986.

Cultural control: Winter wheat — seed as late as possible to avoid the migration of aphids from ripening spring cereals. Spring wheat — seed early since virus damage is less on more mature plants.

RESISTANT VARIETIES: None

INTERMEDIATE: *Hard red:* Sinton

SUSCEPTIBLE: All others

Chemical control: None. Contact insecticides are used in Europe with varying success by following a forecast system timed to coincide with the migration of aphids into the crop. Killing off the aphids thus prevents spread of this virus disease.

Leaf rust

Leaf rust in some years is a destructive disease of soft white wheat. This rust fungus is made up of many distinct strains known as physiologic races. A new cultivar may be classed as resistant at first, but as it becomes more widely grown, the leaf rust races that can attack it tend to become more prevalent year by year until the cultivar has to be regarded as susceptible.

Cause: A fungus, *Puccinia recondita.*

Symptoms: Although leaf rust is largely confined to the leaves of wheat plants, it also occurs to a lesser extent on leaf sheaths, but unlike stem rust it does not penetrate the stem tissue. Leaf rust pustules are nearly round. They may be so closely spaced on heavily rusted plants that they give the leaves an orange-red appearance. As the plant matures, the rust pustules darken and may appear black. The dark color is caused by the formation of thick-walled, dark brown, overwintering spores.

Disease cycle: The black spores survive overwinter on straw but the red spores or summer spores survive the winter only in the southern United States and occasionally farther north where winter wheat is grown.

The overwintering black spores germinate in the spring. These spores cannot infect wheat, but they can infect certain other plants, particularly some species of *Thalictrum* (Meadow rue). The rust spores formed on meadow rue, in turn, infect wheat, to produce the red (summer) stage. The species of *Thalictrum* that are native to North America are so highly resistant to leaf rust that they do not contribute to its spread. In North America, the persistence of leaf rust from year to year is due to the overwintering of the red stage in the southern United States and Mexico and the wind-borne northward movement of the disease each spring on sequentially maturing wheat crops.

Cultural control: As the disease is most severe in late-seeded wheat where the fungus has had time to build up, early seeding could help avoid high infection levels. Most hard red spring wheat and durum wheats are resistant to this disease. It is not easy to breed cultivars resistant to all leaf rust races.

RESISTANT VARIETIES: *Hard red:* Benito, BW593, Columbus, Glenlea, Kenyon, Lancer, Roblin, Sinton, Wildcat, PT325. *Durum:* Arcola, Coulter, Hercules*, Macoun, Medora, Sceptre, Wascana, Wacooma. *Prairie spring:* HY320.

INTERMEDIATE: *Hard red:* Katepwa, Napayo, Neepawa, Pitic 62, Selkirk*.

SUSCEPTIABLE: all others.

Chemical control: Dithane M-45 (See label for directions).

Temporary registration only.

Powdery mildew

Powdery mildew occurs mainly during dry, cool seasons and can cause considerable damage. Although local infections occur almost every year, only occasionally do widespread epidemics develop in Alberta. Serious losses often occur in soft white spring wheat

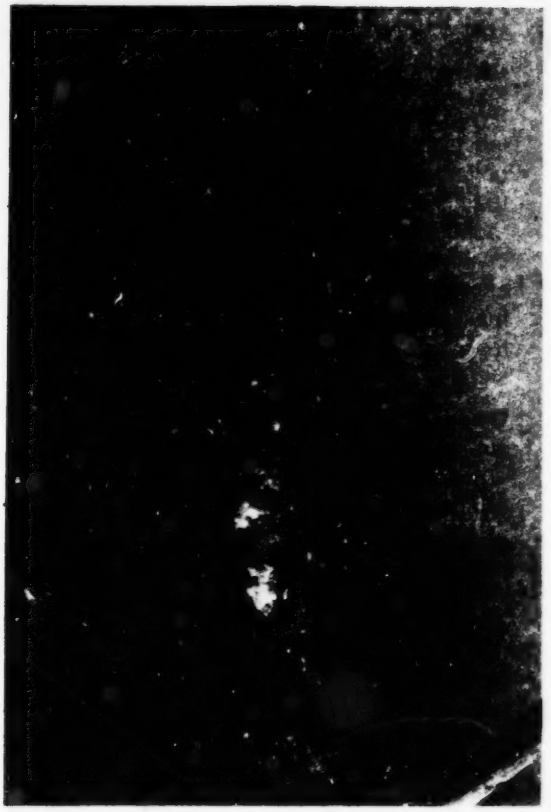


Figure 7. Powdery mildew on flag leaf of Owens wheat — White mold covers leaf later becoming greyish and covered with pepper-like fruiting structures.

grown under irrigation. Powdery mildew of wheat does not attack barley and vice versa. Moreover each of these forms of powdery mildew is made up of several races, which can be distinguished from one another only by their ability or inability to attack different cultivars of the host crop.

Cause: A fungus, *Erysiphe graminis*

Symptoms: At first, powdery mildew may be observed as small grayish-white patches on the lower leaves. These spots resemble very small cushions of white powder (mycelium). These spots increase in number and size until the whole leaf and sheath area is covered with a whitish, powdery mass. Infected plants are stunted and their leaves eventually wither and shrivel up. The whitish-powdery spots eventually become spotted with minute black dots which are the sexual fruiting bodies of the fungus. When infection is heavy, wheat plants may fail to head.

Disease cycle: Powdery mildew survives the winter as black fruiting bodies or as grayish mats of mycelium on the remains of infected plants or on winter wheat infected in the fall. Spores produced in the spring are moved around by air currents, those that fall on on growing wheat plants can cause infections that develop a new crop of spores. Unlike the spores of many fungi, those of powdery mildew can germinate in dry air. Plant infection and spread of the disease are not dependent on dews and rains. In fact, frequent rains hinder the development of powdery mildew.

RESISTANT VARIETIES: None. This disease is rarely a problem on hard red spring or durum wheats.

INTERMEDIATE: *Soft white spring:* Fielder, Owens. *Soft white winter:* Nugaines

Chemical control: Bayleton (see label for directions) Temporary registration only for winter wheat.

Black point and smudge

Black point and smudge are terms used to describe a brownish or black discoloration of the kernels, usually involving the germ end.

Cause: A group of fungi, *Cochliobolus sativus, Alternaria* spp. and *Pseudomonas syringae.*

Symptoms: According to the Canadian grain grading regulations, the term black point applies to the discoloration of the germ and less than one-half of the surrounding area, but not extending to the crease; the term smudge for grading purposes is applied to grains having more than one-half the surface area discolored or, if less, extending into the crease; the pinkish-red discoloration associated with scab and tar spot is included in the definition of smudge.

Disease cycle: The cycle is similar to black point, smudge, and scald in barley. The fungus overwinters in wheat residue, in the soil or on the seed. The pathogen, *C. sativus*, may survive in the soil as thick-walled spores for several years. Seedlings are infected by spores from the soil, crop residue or inoculum on the seed. During the growing season, spores are produced on diseased lower leaves spreading the disease outward and to the upper leaves and head. Rainfall during seed maturation favors the development of black point.

Cultural control:

RESISTANT VARIETIES: None.

Chemical control: None.

Stripe rust

This disease can cause substantial damage to soft white spring wheat yields. Several races of stripe rust with a very wide host range have been identified.

Cause: A fungus, *Puccinia striiformis*

Symptoms: Stripe rust produces yellow pustules in very distinct long stripes on the head and leaves. Pustules on the leaves elongate and then extend the entire length of the leaf blade. Late in the season, the yellow

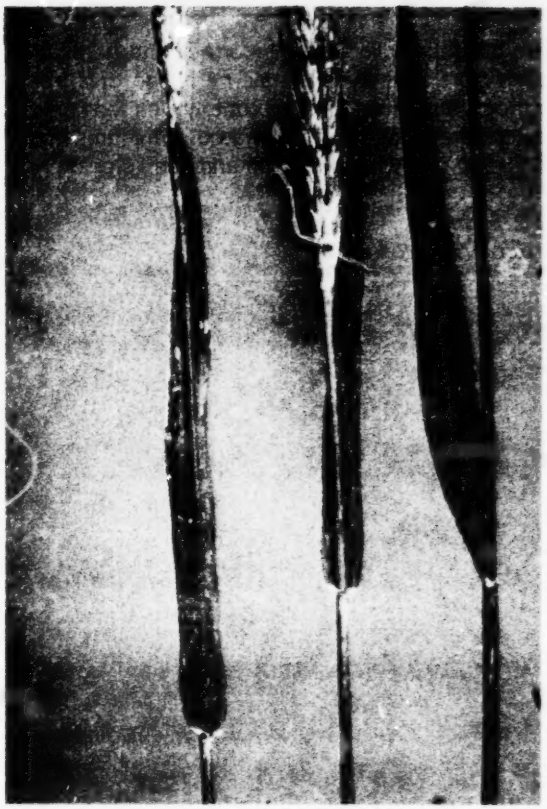


Figure 9. Stripe rust on Fielder wheat — Rust pustules occue in pronounced stripes along the leaf

spore (summer) stage is replaced by dark brown spore (winter) stage. Heavy infection results in plant defoliation and shrivelled seed.

Disease cycle: Stripe rust has no known alternate host. The brown winter spores can readily germinate in the spring, producing spores that appear functionless. The fungus overwinters in the yellow spore stage or as dormant mycelium in infected leaves of native grasses and winter wheat in the Pacific Northwest of the United States and occasionally in Canada.

Cultural control: Resistant varieties provide the most effective means of control. Sources of race-specific resistance and slow rusting resistance have been identified and resistant cultivars are being developed.

RESISTANT VARIETIES: None of the soft white wheats. *Winter wheat:* Norwin
INTERMEDIATE: *Soft white*: Owens
SUSCEPTIBLE: *Soft white*: Fielder

Chemical control: Bayleton (See label for directions). *Temporary registration only.*

Non parasitic diseases of wheat

Many diseases or disorders affecting wheat are not caused by a living organism such as a fungus or bacterium. These diseases are called nonparasitic, since no infectious organism is involved. Causes range from nutrient deficiencies to weather induced disorders to herbicide injuries.

Splotch

This is a leaf disorder common on durum wheat and likely responsible for yield loss.

Cause: Uncertain but is probably due to marginal shortage of nitrogen.

Symptoms: Oval yellow spots appear first on lower leaves and later on the whole plant. These spots enlarge and turn white.

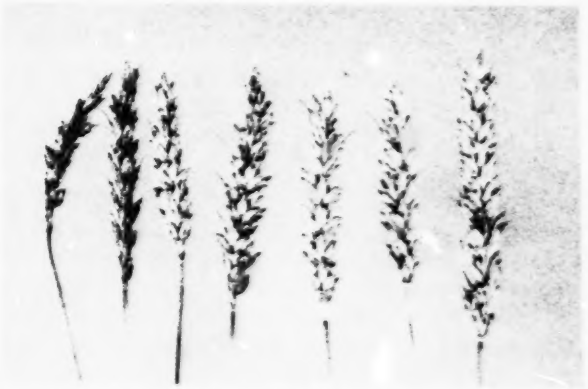
Control: Carry out a soil nutrient analysis and follow recommended fertilizer inputs for the durum crop.

Melanosis

A browning of the heads and upper stems of wheat resulting in shrivelled grains or absence of grains.

Cause: Likely a low availability of copper - an essential micronutrient.

Symptoms: The melanosis typically occurs in streaks or patches in fields, generally on sandy type soils. In the early milk stage of growth the heads and upper stems turn a purplish brown. At maturity the heads retain the brown color and are empty or contain shrivelled grains.



Melanosis — copper deficiency in Park wheat

Control: Park wheat is most prone to this problem whereas Neepawa appears to be unaffected. Research is still ongoing at Agriculture Canada, Lacombe, towards a solution to this problem.

Temperature injury

Heat banding (Rugby stocking)

Unusually high or low temperatures in the spring can cause distinct banding of emerging seedling leaves. Frost, bright hot sunlight or very dry soil conditions can

cause repeated white bands called rugby stocking on the newest part of the leaf to emerge from below ground. Damage may take place over several days. Seedlings generally recover when temperatures improve.

Frost

Frost of course can cause severe damage to immature grain heads in late summer or early fall. Temperature drops of as little as -1 to -2°C can cause considerable losses. Damage is usually most severe in the lower parts of grain fields where frigid air accumulates.

Figure 10. Low temperature winterkill on wheat.

Chemical Injury

Herbicides applied at the incorrect time, herbicide residues from preceding crops, herbicide drift from other crops, as well as from improperly cleaned spraying equipment, may cause a range of symptoms from stunting, and yellowing to kinking and head sterility.

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